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**EVALUATION OF LORING AIR FORCE BASE, MAINE,
IN PREPARATION FOR A PUBLIC HEALTH ASSESSMENT -
DATA GAP SAMPLING AND ANALYSIS PLAN**

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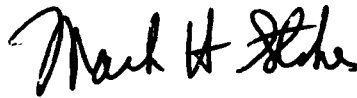
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The Armstrong Laboratory Occupational Medicine Division (AL/OEM) assists Major Air Commands (MAJCOMs) and installations prepare for public health assessments (PHAs) conducted by the Agency for Toxic Substances and Disease Registry (ATSDR). The Headquarters, Air Combat Command (HQ ACC) Bioenvironmental Engineering Office requested that the Environmental Sciences Branch (AL/OEMH) accomplish a site visit and prepare a data gap sampling and analysis plan (DGSAP). This plan identifies information needed for the PHA. ATSDR-developed public health assessment methodologies and future land use scenario considerations were used to arrive at DGSAP recommendations. The PHA methodologies focus on public health and sometimes require different information than needed for the Environmental Protection Agency (EPA) directed Installation Restoration Program (IRP) process.

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LIST OF ACRONYMS

ACM	-	Asbestos-Containing Material
AFB	-	Air Force Base
AL/OEM	-	Armstrong Laboratory Occupational Medicine Division
AL/OEMH	-	Environmental Sciences Branch
AOC	-	Area of Concern
ARARs	-	Applicable or Relevant and Appropriate Requirements
ASTM	-	American Society for Testing and Materials
ATSDR	-	Agency for Toxic Substances and Disease Registry
BEE	-	Bioenvironmental Engineering
BTEX	-	Benzene, Toluene, Ethylbenzene, and Xylene
CERCLA	-	Comprehensive Environmental Response, Compensation, and Liability Act
°C	-	Degrees Celsius
CM	-	Centimeter
COC	-	Chemical(s) of Concern
DBCRA	-	Defense Base Closure and Realignment Act
DGSAP	-	Data Gap Sampling and Analysis Plan
DQOs	-	Data Quality Assurance Objectives
DI	-	Deionized Water
EPA	-	United States Environmental Protection Agency
°F	-	Degrees Fahrenheit
FFA	-	Federal Facility Agreement
FLDD	-	Flight Line Drainage Ditch
FTA	-	Fire Training Area
GC	-	Gas Chromatograph
GFAA	-	Graphite Furnace Atomic Absorption
GW	-	Ground Water
HC	-	Hydrocarbon
HQ ACC	-	Headquarters Air Combat Command
ICP	-	Inductively Coupled Plasma
IRP	-	Installation Restoration Program
IRPIMS	-	Installation Restoration Program Information Management System
JA	-	Judge Advocate (Legal)
LF	-	Landfill
MAJCOM	-	Major Command
MAP	-	Management Action Plan
MDIFW	-	Maine Department of Inland Fisheries and Wildlife
MEDEP	-	Maine Department of Environmental Protection
MPH	-	Military Public Health

MSL	-	Mean Sea Level
NA	-	Not Applicable
NEPA	-	National Environmental Policy Act
NIOSH	-	National Institute for Occupational Safety and Health
NPDES	-	National Pollution Discharge Elimination System
NPL	-	National Priorities List
OU	-	Operable Unit
PA	-	Public Affairs
PA/SI	-	Preliminary Assessment/Site Investigation
PAH	-	Polynuclear Aromatic Hydrocarbons
PARCC	-	Precision, Accuracy, Representativeness, Completeness, and Comparability
PCB	-	Polychlorinated Biphenyl
PCOC	-	Potential Chemical of Concern
PHA	-	Public Health Assessment
PID	-	Photoionization Detector
POL	-	Petroleum, Oil, and Lubricants
POVM	-	Passive Organic Vapor Monitor
PVC	-	Polyvinyl Chloride
QA/QC	-	Quality Assurance/Quality Control
RCRA	-	Resource Conservation and Recovery Act
RI/FS	-	Remedial Investigation/Feasibility Study
SVS	-	Soil Vapor (Gas) Survey
SW	-	Solid Waste
TSCA	-	Toxic Substances Control Act
USAF (AF)	-	United States Air Force
VOA	-	Volatile Organic Acid
VOC	-	Volatile Organic Compound
WIMS-ES	-	Work Integrated Management System - Environmental Subsystem
WWTP	-	Waste Water Treatment Plant

EVALUATION OF LORING AIR FORCE BASE, MAINE, IN PREPARATION FOR A PUBLIC HEALTH ASSESSMENT - DATA GAP SAMPLING AND ANALYSIS PLAN

INTRODUCTION

Purpose

The Armstrong Laboratory Occupational Medicine Division (AL/OEM) assists Major Air Commands (MAJCOMs) and installations prepare for public health assessments (PHAs) conducted by the Agency for Toxic Substances and Disease Registry (ATSDR). The Headquarters, Air Combat Command (HQ ACC) Bioenvironmental Engineering Office requested that AL/OEMH (Environmental Sciences Branch) accomplish a site visit and prepare a data gap sampling and analysis plan (DGSAP). This plan identifies information needed for the PHA. ATSDR-developed public health assessment methodologies and future land use considerations were used to arrive at DGSAP recommendations. The PHA methodologies focus on public health and sometimes require different information than needed for the Environmental Protection Agency (EPA) directed Installation Restoration Program (IRP) process.

The ATSDR has completed a consult at Loring Air Force Base (AFB) (Appendixes A, B, C). This DGSAP addresses sampling to meet their recommendations. In addition, AL/OEMH has identified data gaps in preparation for the broader scope PHA to be completed by ATSDR in the future. ATSDR is willing to review and comment on sampling plans to evaluate whether it meets their PHA needs. Therefore, this plan should be sent to ATSDR for their review.

Public Health Assessment Process

The IRP at Loring AFB constitutes the basis for response actions to environment concerns from past chemical releases at Loring AFB. IRP actions are oriented toward identifying hazardous and/or toxic waste sites, characterizing environmental contamination, and developing and implementing remediation strategies in a timely and cost-effective manner.

Although IRP's complement and are essential to a PHA, the focus of IRP activities is site remediation. The PHA, however, is human health-oriented. A PHA consists of an evaluation of data and information on the release of potentially hazardous substances into the environment in order to (1) assess any past, current, or future impact on public health, (2) develop recommendations (e.g., health advisories), and (3) identify studies or actions needed to evaluate, mitigate, or prevent human health effects.

The PHA evaluates three primary types of information: environmental data, community health concerns, and health outcome data. Environmental data are used to analyze past, current, and possible future exposure pathways by linking five elements:

- 1) source (e.g., landfill, spill)
- 2) transport media (e.g., water, air, soil, biota)
- 3) exposure point (e.g., drinking and shower water, food source)
- 4) route of exposure (e.g., inhalation, ingestion, dermal absorption)
- 5) receptor population (e.g., workers, children)

Loring's IRP sites are only of public health concern if each of the five elements (including the presence or possible presence of a receptor population) may have or are known to have occurred in the past, or have a potential of occurring in the future. It is the Base's responsibility to evaluate the five pathways to ensure that potential public exposures have been identified and properly quantified.

Sites that would not be considered in need of IRP remediation or additional monitoring may be of public health concern. For example, physical hazards at a waste site, such as an open pit with an inadequate barrier between the pit and the community, or off-site exposure pathways resulting from base contamination, are often evaluated during a PHA. In addition, available community-specific medical and public health information are reviewed under a PHA, and any community health concerns associated with base activities (real or alleged) are thoroughly investigated.

The PHA is a qualitative assessment, compared with the more quantitative risk assessment required under IRP. When a PHA identifies data gaps (information missing from the five elements of environmental data), the potential exposures are evaluated based on a "worst-case" scenario. The major conceptual and methodological differences between the PHA and IRP processes are summarized in Table 1.

The purpose of this report is to (1) evaluate existing base activities to identify data gaps prior to the ATSDR PHA investigation, and (2) recommend environmental sampling and analyses, and other PHA associated activities to fill the identified data gaps. This will ensure the Loring PHA Team will use sufficient and relevant information to make decisions that will control human health hazards arising from base operations and meet ATSDR's needs for accomplishing a PHA. AL/OEMH has the technical ability to assist Loring AFB review sample results and identify if a public health concern exists.

AL/OEMH Base Scoping Visit Activities

During the base scoping visit, 27 Sep - 1 Oct 93, environmental sampling data and other existing IRP and bioenvironmental engineering (BEE) documentation were evaluated, sites were visually observed, and community health concerns were identified

**Table 1. Conceptual and Methodological Differences
Between the PHA and IRP Processes**

Area of Comparison	PHA	IRP
Conceptual Criteria		
Investigative Approach	Qualitative, site-specific, advisory (no regulatory authority)	Quantitative, compound-oriented and has regulatory authority
Health Data	Medical and public health perspectives used to assess health hazards	Statistical and biological models used to estimate health risks
Existing Morbidity/ Mortality Data	Considered	Not considered
Environmental Concentration for Exposure Assessment	Highest single value, unless proven as an outlier	Considers the distribution of values
Point of Exposure for Ambient Air Monitoring	Breathing zone	Typically at stack height
Potential Receptor Population	Entire population (includes sensitive individuals)	Emphasis on sensitive receptor population(s)
Ecological or Biotic Sampling	Requested if biota exposure pathway may adversely affect human health	Considers threats to ecological components, based on a conceptual site model.
Physical Hazards	Considered	Not considered
Asbestos Exposure	Considered	Not considered (regulated under TSCA)
Impact of Contamination	Can extend off-site	"At the fence-line"
Methodological Criteria		
Metals Analyses of Water	Unfiltered samples	Filtered samples
Soil or Sediment Samples	Grab samples	Composite samples allowed
Surface Soil Samples	Top 3 inches	Typically top 6 inches

by AL/OEMH. The CES/CEV (Environmental Flight) provided detailed environmental information about areas of public health importance to help identify data gaps. Legal (JA), Public Affairs (PA), military public health (MPH), and BEE officers were contacted to discuss their roles in the PHA process and exchange relevant information. Based on the information obtained from these focused evaluations, there are no imminent public health hazards due to environmental contamination at Loring AFB. There are, however, a number of sites where PHA data gaps were observed and past, current, or ongoing environmental evaluations do not address the gaps. More complete characterization of potential chemicals of concern (PCOCs) needs to be accomplished at these sites (Table 2). This table includes (1) future land use scenarios, (2) PCOCs, (3) media of concern (soil, water, air, or biota), and (4) Operable Unit (OU), (5) Work Integrated Management System - Environmental Subsystem (WIMS-ES), and/or (6) Site ID. Sites evaluated where data is sufficient to complete the PHA evaluation are presented in Table 3. These sites have no data gaps based on past, current, or future preliminary assessments/site investigations (PA/SI) and/or remedial investigations/feasibility studies (RI/FS).

Site Description

Loring AFB is located in the northeastern corner of Maine, occupying approximately 9,000 acres in Aroostook County. The Base is located approximately 2 miles outside the town of Limestone and 3 miles from the Canadian border. State Highway 89 provides access to Loring AFB via a west gate on Sawyer Road and an east gate on Corrow Road. Nearby land uses include agriculture, forestry, and low density residential with some minor commercial and industrial uses. The Base's perimeter fence has been removed and access is restricted only by patrolling security police.

Approximately 53 percent of Loring AFB is in a seminatural to natural ecological condition with coniferous forests, hardwood forests, mixed forests, forested bogs, streams, and ponds. Highly variable weather characterizes the climate of the Aroostook Region. Monthly mean temperatures vary from 11 degrees Fahrenheit (°F) in January to 66°F in July. The average annual precipitation is 39 inches. A considerable percentage of precipitation at Loring AFB results from snowfall, with an average of 118 inches per year. The physiographic setting for Loring AFB is an area of undulating hills in the Lower Aroostook River Valley. The base itself is located on a relatively flat plateau that slopes gently to the southwest. Topographic elevations at the base range from approximately 800 feet above mean sea level (MSL) to approximately 550 feet above MSL in the southwest corner. The Lower Aroostook River Valley is characterized by alluvium, swamp deposits, lacustrine deposits, glacial outwash, ice-contact deposits, glacial till, and carbonate bedrock.

Table 2. Data Gap Summary
Loring AFB, Maine

Operable Unit	WMS-ES Site ID	Future Use Scenario	Potential Chemicals of Concern	Pathways of Concern***							
				Surf Water	GW	Surf Soil	Sediment	Sub Soils	Biota	Air	
OU-2A	LF-1/Green Pond	Active Recreation	Lead, Zinc, Arsenic, Mercury	X	X					X	
OU-7A	SS-04 Receptor Site (Jackson Well)	Residential	VOC, VOA, PAH		X						
OU-8	SS-17 Underground Transformer Site	undeveloped/ Agriculture	PCBs			X					
OU-12	Flight Line	Air-Related Industry	Glycols		X						
OU-13	ST-10/Flight line Drainage Ditch	Air-Related Industry	BTEX								X
None	On-base Segment - Searsport Pipe	Air-Related Industry/ Passive Recreation	Petro HCs BTEX	X				X			
None	Former Army Barracks Foundations/ and 300-Series Buildings	Passive Recreation and Nat. Res. Conservation	ACM Building Materials			X					

* Future Land Use Scenario - projected use of Base following closure.

** Potential Chemicals of Concern (PCOCs) - chemicals that may be present and need to be more fully characterized.

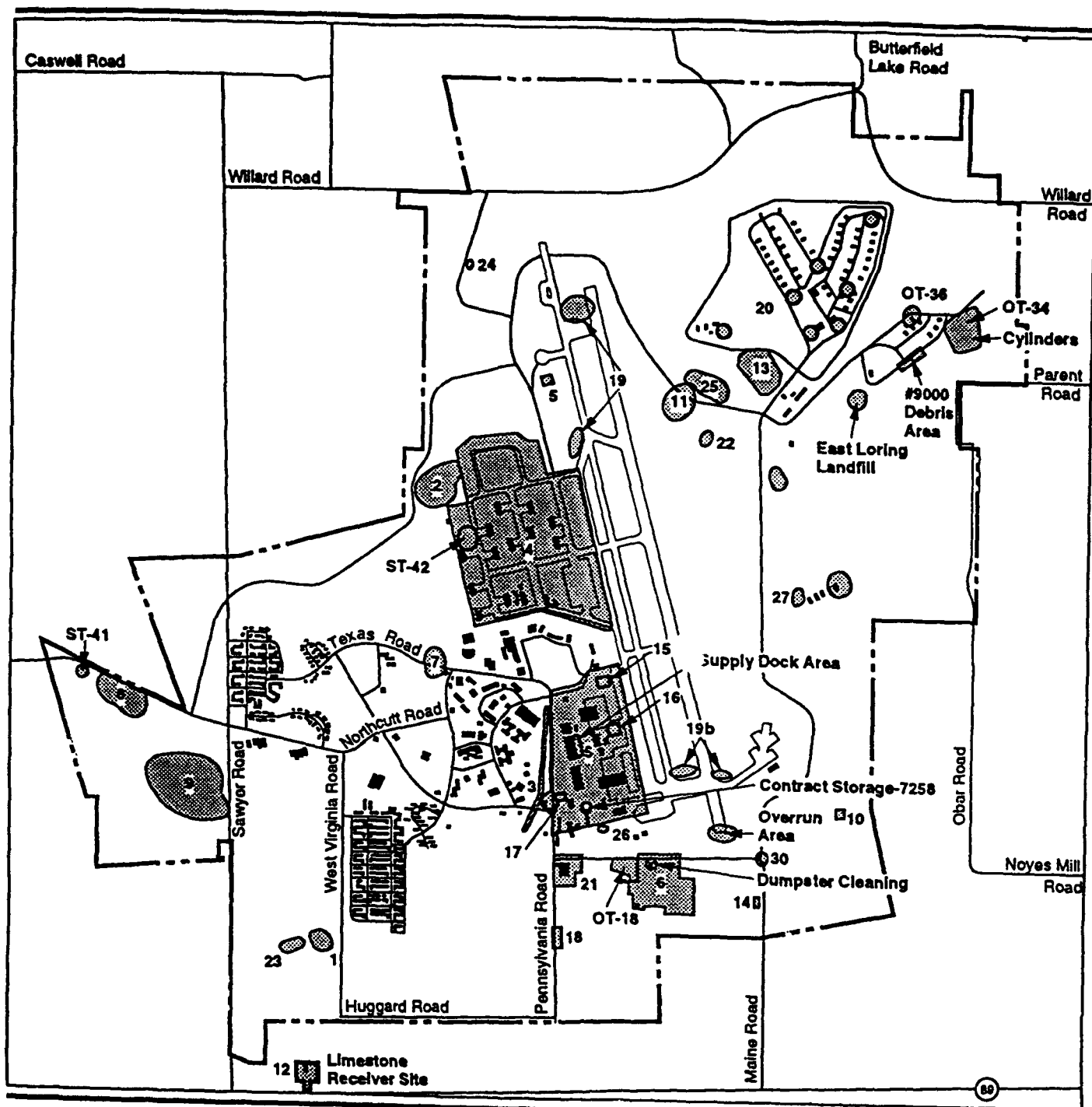
*** Pathways of Concern - environmental media that should be sampled.

Table 3. Sites With No Identified Data Gaps
Loring AFB, Maine

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OU	AOC	WIMS-ES	Site Description	OU	AOC	WIMS-ES	Site Description
1	20	RW-24	Low-level radioactive sites	6, 12	10	SS-08	Railroad maintenance site
2a, 4	9	LF-3	Coal ash pile	6, 12	14	ST-16	E gate waste storage area
2, 4	8	LF-2	Landfill #2	6, 12	19	SS-03	S fuel drop site
2, 4	9	LF-20	Landfill #3	6, 12	19	SS-14	N fuel drop site
3	NA	NA	#9000 debris area	7, 12	1	SS-05	Quarry
3	NA	NA	Overrun area	8, 12	11	FT-07	Fire training area
3	NA	NA	Old BX service station UST	9, 12	5	SS-12	Auto hobby shop
3	NA	NA	Solvent/paint dock area (7220)	9, 12	5	SS-12	Snow barn
3	NA	NA	Dumpster Cleaning (7841)	9, 12	17	SD-32	Power plant drain pipe
3	NA	NA	EOD area-cylinders	9, 12	17	SD-37	Former vehicle motor pool
3	NA	NA	F-106 crash site	10, 12	5	WP-40	Entomology Shop
3, 4	23	LF-43	Chapman pit debris area	10, 12	5	SS-12	Solvent storage bldg
3, 12	22	LF-44	Prime BEEF debris area	10, 12	5	ST-21	Pumphouse 1 (8210)
3, 12	24	LF-45	Ohio Rd debris area	10, 12	5	ST-15	Pumphouse 2 (8270)
3, 12	25	LF-46	Oklahoma Rd debris area	11, 12	6	ST-06	Fuel Tank Farm
3, 12	26	LF-47	Demineralization plant	11, 12	6	SD-39	Oil/water separator bldg 7817
3, 12	27	LF-48	DRMO (8951 and 8960)	11, 12	18	SS-31	Refueling maintenance area

OU	AOC	WMS-ES	Site Description	OU	AOC	WMS-ES	Site Description
3, 12	27	LF-48	DRMO (8951 and 8960)	11, 12	18	SS-31	Refueling maintenance area
3, 12	27	LF-48	East Loring landfill	11, 12	21	SS-33	Vehicle maintenance bldg 7500
5	4	ST-11	Soil storage	11, 12	27	O-18	Fly ash disposal site coal storage pile
5, 9, 10	5	SS-12	Flight line	11, 12	27	O-19	coal storage area
5, 12	4	ST-11	Nose dock area	12	27	ST-41	Water softening plant (1008)
5, 12	5	SS-35	Former jet engine test area	NA	27	ST-42	Ammonia transfer facility (8719)
5, 12	7	ST-13	BX service station area	NA	NA	SD-38	Oil/water separator



EXPLANATION

--- Base Boundary

■ Sites by Area of Concern (AOC)

Sites, Zones, and OUs
Under Investigation



MAP LofV024

Figure 1

Loring Air Force Base, Maine - 4 October 1993

IRP and ATSDR Background Information

Loring AFB was placed on the EPA's National Priorities List (NPL) on 21 February 1990. Currently, there are 51 areas of concern (AOC) and several new sites undergoing PA/SI (Figure 1). The 51 sites are being evaluated under an USAF, EPA Region I, and Maine Department of Environmental Protection (MEDEP) Federal Facility Agreement (FFA). This agreement requires that environmental restoration efforts conform to Comprehensive Environmental, Response, Compensation, and Liability Act (CERCLA), Resource, Conservation and Recovery Act (RCRA), National Environmental Policy Act (NEPA), and Defense Environmental Restoration Guidelines.

The ATSDR was mandated by CERCLA and RCRA legislation to complete PHAs at all NPL sites. Thus, ATSDR must perform a PHA at Loring. During a 17-day September 91 site visit to rank Loring amongst all 34 USAF NPL installations, ATSDR completed a public health consult for Loring AFB (Appendixes A, B, C). This initial consult (Appendixes A and B) focused on identifying areas of public health concern and information gaps, and categorizing the base. Loring AFB was categorized as a class "C" public health concern (no completed human exposure pathways identified and no specific community health concerns were reported) (Appendix A). The initial consult was followed by an addendum, dated 17 Feb 93, which focused on health concerns from elevated manganese concentrations detected in a single privately-owned off-base well (Appendix D). The base addressed all major areas of concern identified in the consult and addendum. However, glycol sampling, recommended in ATSDR's initial consult, has not been completed. The health concern associated with glycol is possible receptor exposures primarily through the ingestion (e.g., consumption of biota). The following sections will include information on possible glycol (ethylene and propylene) exposures and whether a future evaluation is warranted.

The ATSDR indicated that Loring's waste water treatment plant (WWTP) may be adversely affecting biota in Greenlaw Brook. The Maine Department of Inland Fisheries and Wildlife (MDIFW) 1986 *Aroostook River Atlantic Salmon Management Report* was referenced. AL/OEMH contacted David Basley Regional Fishery Biologist (MDIFW), to discuss the report. The report identified high chlorine content in Loring's WWTP effluent as the possible source of caudal fin erosion in salmon fry released in Greenlaw Brook immediately off base. At the time of the report, the WWTP discharged to Greenlaw Brook. A 1986 upgrade of the WWTP rerouted effluent discharge to the Little Madawaska River, downstream from Greenlaw Brook. Due to this upgrade and continual compliance with the National Pollution Discharge Elimination System (NPDES) sampling requirements for total chlorine (and all other parameters), adverse impact on stocked fish from WWTP effluent is not likely to be considered a public health concern by ATSDR.

Current Status of Loring AFB

Pursuant to the Base Closure and Realignment Act of 1988 and the Defense Base Closure and Realignment Act of 1990 (collectively referred to as DBCRA), Loring AFB was selected for closure and associated property disposal during Round II Base Closure Commission deliberations. Loring AFB will be officially closed in September 1994. This DGSAP was based on future land use scenario information found in the Management Action Plan (MAP). The actual reuse of the land may determine additional sampling needs and clean-up levels.

PHYSICAL HAZARDS

Physical hazards are considered in the PHA; several tripping/falling hazards were observed:

Flight Line Drainage Ditch (ST-10)

A deteriorated bridge, crossing Flight Line (Pennsylvania Rd) Drainage Ditch, presents a falling hazard.

Fire Training Area (FT-07)

The broken grate covering the fire training area (FTA) oil-water separator presents a trip/fall hazard. Physical injuries could result from a fall in the separator area.

Underground Transformer Vaults (SS-17)

Although plywood covers are available, several underground transformer vaults (SS-17), located near East Loring Lake, were not covered. The lack of perimeter fences around the Base and site specific restrictions permit access. Falls could occur to people who use nearby areas for recreational purposes, workers who are unaware that these sites may be contaminated, or children playing in the area.

Recommendations: The deteriorated bridge needs to be replaced, repaired, or removed. Properly cover the oil-water separator, until the FTA tanks and lines can be removed. Prevent access to the underground transformer vaults.

IDENTIFICATION OF DATA GAPS

Although extensive monitoring data are available for many of the IRP sites and additional sampling is planned, the PHA process uses different methodologies and

assesses areas not typically evaluated through IRP activities. Thus, it requires consideration of a broader range of environmental issues than the IRP. Data gaps or concerns exist for six on-base sites.

This section describes the site specific data gaps relevant to the ATSDR PHA process, followed by sampling and analyses recommendations to address the data gap(s) (Table 2). These recommendations have been developed with the understanding that extensive environmental (e.g., IRP and BEE) sampling at Loring AFB has occurred and that ongoing and future sampling plans have already been developed or are currently being developed for most areas. In addition, the recommendations are also consistent with known PHA approaches, objectives, and policies.

Past Completed Exposures

A completed exposure has occurred or is occurring when environmental data suggests that a receptor is being exposed to a PCOC. ATSDR considers past exposures, since they may contribute to present or future health problems. Three past completed exposures to environmental contaminants were identified: 1) the receiver site (SS-04) well, 2) power plant drainage pipe (SD-32) and former vehicle motor pool (SD-37), and 3) vehicle maintenance building (O-33).

Receiver Site (SS-04)

The SS-04 well was a completed pathway for a few receiver site workers, until fuel odor in the water prompted the base to discontinue the well as a potable water supply. A spill occurred near the receiver site and clean-up was not initiated prior to notification from nearby workers. Exposures are estimated to have occurred at very low levels for a few weeks. Since SS-04 groundwater is contaminated, the nearby Jackson well is a potential future pathway of exposure.

Recommendation: Sample the Jackson Well semiannually.

IRP Remediation Activities (SD-32/SD-37 and OT-33)

The recent excavations at the SD-32/SD-37 drainage pipe and the OT-33 maintenance building areas resulted in acute exposures of volatile organic compounds (VOCs) to subcontract personnel. One worker in both of these areas experienced narcotic-like effects from acute exposures. They were immediately assisted out of the work site and their recovery was complete. Because of the identified past completed pathways, there is continuing concern for future remedial worker exposure resulting from digging at IRP sites.

Recommendation: Ensure subcontractors/contractors exercise their health and safety plan requirements, during future remediation activities. This should prevent unintentional exposures to the residents that utilize the Jackson Well and those employees involved in remediation activities.

Potential Exposures

IRP Remedial Activities

Accessibility to IRP sites undergoing remediation after the military presence leaves the base and land parcels are released is of public health concern. Loring AFB no longer has a perimeter fence and the Security Police are the only means of keeping intruders off base. In addition, most IRP sites do not have limited access. Since future chemical exposures (inhalation, ingestion, and dermal) can occur to recreational land users, remediation workers, and children playing in nearby areas, this concern must remain a top priority throughout the Loring AFB IRP process. Sites should be secured and warnings posted, if potential exposures exist at a site. Only authorized personnel should be permitted on IRP sites.

Landfill #1 (LF-1)

Originally a gravel pit, LF-1 was a disposal area from 1952-1956, receiving primarily construction debris. Low-level metal contamination from landfill was monitored at the LF-1 seep into Green Pond. The data gap is whether the metals are bioaccumulating in the stocked fish. The potential receptors are currently on-base personnel who eat Green Pond stocked fish. Future biota pathway exposure receptors may be the off-base residents, since the land use scenario indicates that the pond may become a recreational area.

Recommendation: Sample Green Pond fish tissue to ensure metals are not bioaccumulating in the fish. In addition, do not stock Green Pond until sampling results have been evaluated.

Underground Transformer Vaults (SS-17)

Underground transformer vaults located in SS-17 no longer contain transformers. No information was found as to whether post removal PCB sampling was performed at each vault following transformer removal. If no samples had been collected or their validity is in question, the vaults would have to be sampled or resampled to ensure that they are PCB-free. Potential receptors include curious children, recreational land users, and remedial workers.

Recommendations: Identify whether PCB samples were taken in each vault that housed PCB-containing transformers. If so, evaluate the sample and analytical validity

(including quality assurance/quality control (QA/QC)), and sampling technique appropriateness. If no samples or nonvalidated data were collected, take swipe samples for PCBs in the underground transformer vaults.

Flight Line Drainage Ditch (ST-10)

The flight line drainage ditch (FLDD) is in the south-central area of the base and runs along Pennsylvania Road. It is an unlined drainage channel and tributary to the east branch of Greenlaw Brook. A majority of the storm water runoff from the nose dock area, runways, and the flight line area pass through the storm drainage system. Surface waters and sediments in the ditch have been contaminated by past fuel spills, and maintenance and operation waste disposal practices.

Since access to the FLDD and skimming pond access are unrestricted and known to contain fuels, and there is a large number of potential human receptors who work near the FLDD, this area is of greatest public health importance. Future land use scenarios suggest that this area should remain heavily industrial and potential receptors should continue to be workers; however, access to the FLDD and lack of warning signs may result in future exposures.

The air pathway has not been fully characterized in the FLDD area. Although extensive work has been done to assess COC contamination in and around the flight line and FLDD, no air samples have been taken to evaluate air emissions from this area. The potential receptors are mainly adults working in the area, although lack of restriction suggests that child exposures may also be a concern. Residential receptors closest to the FLDD are nearby dormitory occupants.

Recommendations: Air samples should be taken to evaluate VOC emissions from the FLDD and oil skimming pond area. Benzene, toluene, ethyl benzene and xylene (BTEX) are the recommended VOCs, since they are representative of flight line VOCs and are known to adversely affect human health via the air pathway. Sample results will give an indication of potential worst-case exposures. Another recommendation is to install a lock on the skimming pond access gate to prevent unauthorized entry.

Ground Water (OU-12): Flight Line

ATSDR is concerned about potential glycol (ethylene and propylene glycol) exposures resulting from deicing activities. Because of past deicing activities and subsequent runoff, the ground water downgradient from the flight line is a potential exposure pathway. Route of exposure may be from inhalation and dermal contact, but ingestion is the most likely route. Therefore, the primary concern is potential potable well water contamination.

Several deicing worker personal glycol air samples have been taken in other USAF installations and results were well below health based recommended levels. These results indicate that the inhalation pathway should not pose a health concern. In

addition, ATSDR's *Toxicology Profile for Glycols* indicates that inhalation is of little or no importance as a glycols exposure pathway.

Recommendations: Ground water samples for glycol (ethylene and propylene) should be collected from previously monitored wells. Results should indicate whether glycols in ground water is a public health concern.

On-Base Searsport Pipeline

The on-base Searsport petroleum, oil, and lubricants (POL) pipeline is maintained by the Base. The off-base portion of the pipeline is maintained by the Defense Fuels Service Center. Health concerns are related to possible contamination of surrounding soils from past leaks. Potential exposures are primarily VOC inhalation, ingestion, and dermal contact by on-base personnel. Since Loring AFB is closing, other individuals (e.g., children and recreating adults) may also be receptors unless future access to this area is restricted.

Recommendation: A preliminary evaluation should be made to determine whether the soils under the on-base portion of Searsport pipeline contain VOCs. If areas containing VOCs are found in soils, these areas should be further evaluated.

Former Army Barracks Foundations and 300-Series Buildings

Observations suggest that the former Army barracks foundations and 300-series buildings (Bldg 368 and 374) may contain friable and nonfriable asbestos-containing material (ACM). The 300-series buildings are located near the weapons storage area. The ACM appears to be in the tiles of the Army barracks foundations and in the wall materials and piping insulation in the deteriorated 300-series buildings. These structures may present an asbestos exposure hazard primarily to remediation workers, although there is potential for trespassing and exposure.

Recommendation: The former Army barracks foundations and 300-series buildings should be evaluated for ACM. Identified ACM must be removed prior to disposal of property and/or demolition of building, unless the buildings are demolished entirely as ACM. When the ACM process is initiated, care should be taken to identify all Army foundations and 300-series buildings that may contain ACM.

Community Health Concerns and Health Outcome Data

Community health concerns and health outcome data are of equal importance to environmental data during a PHA. The military public health officer (MPHO) is knowledgeable about available morbidity and mortality studies completed at both regional and state levels and has conducted a few independent studies (e.g., miscarriage

studies). In addition, the MPHO has a working knowledge of the health outcome concerns and views of local health officials and practitioners.

The Wing and CEV PA personnel work cooperatively to identify and address all public concerns. Through attendance at various on and off base meetings and solicitation of questionnaires, the Loring AFB PA staff identifies public concerns. These concerns are addressed by such things as direct question-and-answer sessions, news releases, and newsletters. The PA staff currently is compiling a file which will include all public relations correspondence and activities. This information must be maintained, since it will be of primary concern to ATSDR during their PHA.

Recommendations: Informational sources used by the MPH and PA offices should be maintained and periodically updated. For example, the present MPHO has phone numbers from local health officials and practitioners who are concerned and knowledgeable about community health concerns. These sources must be maintained and health outcome data accessible. Awareness should be heightened in anticipation of the ATSDR PHA site visit.

SITE SPECIFIC SAMPLING AND COLLECTION METHODOLOGY

The following section describes site-specific sampling, analysis, and methodologies for areas where further investigation is recommended. A summary of the proposed sampling and analysis requirements are provided in Table 4. Data quality assurance objectives are described in a later section.

Receiver Site (SS-04)

Sampling and Analysis

Semiannual VOC, volatile organic acid (VOA), and polynuclear aromatic hydrocarbons (PAH) sampling of the Jackson Well is recommended until the remediation has been completed and the site no longer poses a threat to local groundwater supplies (Table 4).

Domestic Well Sample Collection

Samples from domestic wells should be collected from a tap or spigot located as close to the wellhead as possible. The well should be pumped for a minimum of 10 minutes prior to sampling to purge stagnant water from the casing and pressure tank.

Sampling for VOCs requires special care not to agitate the sample and promote volatilization. In addition, no headspace is permitted in the sample container after it has

Table 4. Recommended First Phase Sampling
Loring AFB, Maine

Operable Unit	WIMS-ES Site ID	Chemicals of Concern	Media of Concern	Number of Samples	Sampling/ Analytical Method*	Survey
OU-2A	LF-1/Green Pond	Lead, Arsenic, Zinc Mercury	surface water ground water	3-5 fish	Sample Prep: EPA 4-81-055 & ASTM D 4638-86 Analysis: Series 6010 and 7000	NA
OU-7A	SS-04/ Receptor Site (Jackson Well)	PAHs, VOCs and VOAs	ground water	semiannual	EPA 600 Series	NA
OU-8	SS-17/ Underground Transformer Sites	PCBs	vault surface (e.g., dust)	1 swipe sample (floor of each vault)	EPA 8080 Series	NA
OU-12	Flight Line	Ethylene and Propylene Glycol	ground water	4 samples	Modified 8015	NA
OU-13	ST-10/ Flight Line Drainage Ditch	BTEX	air	6-8 samples	NIOSH 1501	NA
None	On-base Segment - Searsport Pipe	Petro HCs BTEX	surface water sediments	NA	NA	Soil Vapor Survey
None	Former Army Barracks and 300- Series Buildings	Asbestos- Containing Matl (ACM)	building material	2 bulk samples/ potential ACM	Polarized Light Microscopy Analyses	ACM Survey

* Collection methodologies appear in the Site Specific Sampling and Collection Methodology Section
NA - Not Applicable

been filled. VOA containers should be preserved by the laboratory. VOC samples should be collected using a slow controlled pour down the inside of a tilted VOA container to minimize agitation. The sample container should be filled until the meniscus is above the top of the container. The sample bottle should be capped and then inverted and tapped lightly upon the back of the sampler's hand to determine if any air bubbles are trapped within the container. Water should be added to containers with trapped air until no air bubbles are present in the sample.

Once all samples for chemical analysis have been collected, a sample for water characteristics should be collected and analyzed. Water characteristics should consist of temperature, pH, conductivity, and dissolved oxygen. These parameters should be measured in the field using field equipment such as temperature, pH, conductivity, and dissolved oxygen meters. Results of water characteristics testing should be recorded on the sample record sheet for the well being sampled.

Collected samples should be placed in a cooler with bagged ice to maintain a temperature of 4 degrees Celsius ($^{\circ}\text{C}$), and a chain-of-custody form should be completed to ensure proper handling.

Landfill #1 (LF-1)

Sampling and Analysis

Biota sampling is recommended at Green Pond to establish whether a completed pathway exists between the waste materials (metals) in Landfill #1 and the human receptors who may ingest fish from the lake. A single sampling of the edible portions (i.e., fillets) of three to five fish should be adequate to detect the presence of potential metal contaminants. Sample number depends on the size of the fish. The design of this survey is not intended to identify statistical significance, but to assess the potential contamination and bioaccumulation of metals (lead, arsenic, zinc, and mercury). Sampling at Green Pond and at a reference site outside of Loring AFB could be conducted in the spring after ice breakup, but preferably in summer after feeding on pond invertebrates has increased.

Biota Sampling

Fish will be collected from both the water body of interest and a designated reference site. The reference location, identified prior to sampling, will match the study area as closely as possible and will preferably contain the same fish species as found in the water body of interest.

Electroshocking is the preferred method for fish collection. A portable electroshock unit can be employed by the field crew while wading in shallow waters, or in deeper water operated from a boat. Alternatively, fish can be collected by angling or installing

and tending a gillnet employing variable mesh sizes. The edible portion of each fish will be selected for tissue analysis, weighed to the nearest gram, measured, rinsed in site water, and sacrificed.

Immediately following sacrifice, each individual fish will be placed in a nonmetallic container or wrap (e.g., appropriately washed and acid-rinsed glass jars fitted with Teflon lids, or plastic wrap). The samples will then be placed in water-tight plastic bags, labeled and stored on ice. At the end of the sampling day, samples will be frozen using dry ice for transport to the receiving analytical laboratory. The holding time for samples treated in this manner is 14 days from time of sample collection.

Sample Preparation. Information on preparation of tissues for analyses can be found in "Interim Methods for the Sampling and Analysis of Priority Pollutants in Sediments and Fish Tissue." EPA 600/4-81-055. U.S. Environmental Protection Agency, Cincinnati, Ohio, October 1980, and "Guide for Preparation of Biological Samples for Inorganic Chemical Analysis." ASTM. Designation D 4638-86, revised November 28, 1986.

Metals Analyses. The digestion solutions resulting from sample preparation should be analyzed employing graphite furnace atomic absorption (GFAA) or inductively coupled plasma systems (ICP). Because the burdens of metals in fish are often likely to be relatively low (<10 mg/kg wet weight), the GFAA system should be used whenever possible. Analytical methodologies should follow CERCLA SW-846, Series 6010 and 7000.

Underground Transformer Site (SS-17)

Sampling and Analysis

Review the polychlorinated biphenyl (PCB)-containing transformer removal records to determine if validated sampling was accomplished at each site. If no swipe sampling or sample validation was completed, collect them from the concrete floors of the vaults used to store known PCB-containing transformers. A minimum of two samples should be collected from the floor of the vault. Specific sampling locations should be selected where contamination appears evident using best professional judgement.

Swipe Samples

Swipe samples should be collected by thoroughly wiping a precise 10 x 10 centimeter (cm) area on the concrete surface with a hexane-soaked sterile gauze. The analytical laboratory normally provides the sample containers with the hexane wipes inside each container. Gloves should be worn when handling the gauze. To facilitate the collection of samples, a plastic sampling template with a cut-out measuring 10 x 10 cm

should be used to insure that uniform surface areas are sampled. After the selected area is thoroughly wiped with the gauze, the gauze should be placed back in the supplied sample jar and labeled. The template should be rinsed with hexane after each sample to prevent cross-contamination.

Flight Line Drainage Ditch (ST-10)

Sampling and Analysis

A limited air quality survey should be accomplished to evaluate FLDD VOC air emissions. The potential receptors, including adults working in the area or dormitory residents, are being exposed by FLDD contaminants. Several (3-5) 24-hr VOC (e.g., BTEX chemicals) air samples should be collected at the oil skimming pond and outside the dormitory nearest to the FLDD. Sampling should be conducted during different ambient wind conditions.

Air Sampling Methodology

Air samples should be collected using National Institute for Occupational Safety and Health (NIOSH) Method 1501. A passive organic vapor monitor (POVM) or active charcoal tubes can be used as the sampling media. All samples should be taken at fixed locations approximately four to five feet above the ground surface. This will best represent the actual exposures that an individual would receive if located in the sampled area. In addition, care should be taken to ensure that natural and man-made obstructions that could affect or alter the airflow near the sampler intake were avoided. The sample duration should be 24-hours at each location. After a sample has been taken, the sampling tube or POVM should be placed inside ziplock® bags and refrigerated at approximately 4°C to prevent analyte migration.

Chain-of-custody and analyses request forms should be filled out. The chain-of-custody form should ensure that only appropriate personnel handle the samples, and the analyses request form will inform the lab what analytes need to be analyzed.

Each charcoal tube should be analyzed for benzene, toluene, ethyl benzene, and xylene (BTEX) using a gas chromatograph (GC), a second column for confirmation, and a Photoionizing Detector (PID).

Ground Water (OU-12): Flight Line

Sampling and Analysis

Four ground water samples should be collected from the flight line area and analyzed for glycols (ethylene and propylene glycol). Sampling should be accomplished at

previously installed monitoring wells, down gradient from the flight line, and where high glycol concentrations are likely. For example, in the wells where high levels of fuels and/or hydraulic fuels have previously been measured.

These samples are intended to identify if any glycols are present in ground water and should satisfy ATSDR's glycol concern. If glycols are detected, potable well water samples off-base should be collected.

Ground Water Collection Methodology

Purging. Purging of wells is necessary to remove ground water in the well casing which may no longer be representative of the aquifer. The volume of water to be removed is calculated by multiplying the well diameter times the height of water in the well casing. This volume of water is referred to as one purge volume.

Polyvinyl chloride (PVC) bailers or submersible pump should be used to purge the ground water monitoring well prior to sampling. Three purge volumes of water should be removed. If a low yielding well dewateres before evacuation of the required volume, the well should be allowed 30 minutes to recover and bailing or pumping should be resumed. If the well again goes dry, bailing or pumping should cease, and the volume purged should be recorded. Ground water sampling should occur as soon as a sufficient quantity of water is available. All nondedicated field equipment used during purging should be decontaminated by steam cleaning before the next ground water monitoring well is purged. Conductivity and pH should be monitored during purging.

Sample Collection. Ground water sampling activities should be conducted in accordance with Section 4 of the *RCRA Ground Water Monitoring Technical Enforcement Guidance Document* dated September 1986. The following procedure should be used to sample a purged well.

The sampler should don clean protective gloves and attach fresh string made of an inert material to the dedicated PVC bailer. Samples should then be placed in a plastic container.

Once all samples for chemical analysis have been collected, a sample for water characteristics should be collected and analyzed. Water characteristics should consist of temperature, pH, conductivity, and dissolved oxygen. These parameters should be measured in the field using field equipment such as pH meters; temperature, pH, and conductivity meters; and dissolved oxygen meters. Results of water characteristics testing should be recorded on the sample record sheet for the well being sampled.

Collected samples should be placed in a cooler with bagged ice to maintain a temperature of 4°C, and a chain-of-custody form should be filled out detailing the analyses to be performed.

On-Base Searsport Pipeline

Sampling and Analysis

The on-base segment of the Searsport fuel pipeline should be evaluated for releases of petroleum to the underlying soils through a soil gas survey. The soil gas samples should be analyzed for BTEX using a field gas chromatograph. If BTEX chemicals are detected along the pipeline segment, these areas should be investigated further as part of the remedial investigation at the fuel tank farm (OU-11).

Soil Vapor Survey (SVS): Sampling Procedures and Equipment

To collect and analyze a soil vapor sample, a hollow steel sampling probe with a slotted tip is driven into the soil to a specified depth below ground surface and a vacuum pump is attached to purge approximately five probe volumes of vapor. Purging requires between 1 and 20 minutes. A vacuum gauge on the sampling apparatus measures the vacuum between the tip of the probe and the pump. After the appropriate purging period, a valve is closed and the vacuum in the probe decays. The vacuum reading during the purge and the vacuum release time are recorded on the SVS data sheet. In general, the soil's gas permeability is indicated by the vacuum release time and the vacuum during purge. In most situations, vacuum release is rapid (within 3 minutes), and the sampling is considered to be representative of the soil vapor at the sampled depth.

The samples are collected through a septum with a microsyringe and injected into a gas chromatograph for analysis. Once injected into the gas chromatograph, samples are separated on an analytical column and sensed by the detector.

The gas chromatograph is operated in backflush mode to prevent contamination of the analytical column with high concentrations of interfering compounds. Blanks are run to ensure that the system is free of hydrocarbons. As necessary, the instrument is recalibrated by injecting standards and by running ambient air blanks approximately every 2 hours through the day. This recalibration ensures that the system is operating consistently and that the parametric changes caused by temperature fluctuations through the day are accounted for.

Former Army Barracks Foundations and 300-Series Buildings

Asbestos-Containing Materials (ACM) Survey

The potential ACM observed at the former Army Barracks and 300-series buildings should be tested for asbestos content using the procedures described below. At each location, two samples of each potential ACM should be collected for analysis.

Field Survey

A field survey for ACM should be performed to determine if friable materials are present and potentially pose a health risk. A field crew should walk the site performing a visual survey documenting and mapping any areas which appear to contain friable materials. After locating suspect materials, the field personnel should determine representative sample locations. One sample should be taken of each homogenous suspect material.

Sampling Suspect Material

After determining locations for obtaining representative samples, the material should be sampled in the following manner: (1) Use a spray bottle to slightly wet the suspect material, (2) use an exacto-knife® to obtain a small sample, and place it in a clean sample container, (3) tightly seal sample container, (4) use a damp paper towel to clean the outside of the sample container, (5) label the sample container, and (6) send samples to a laboratory for analysis.

Chain-of-custody forms should be initiated at the time of collection by the sampler and shipped in the same container as the samples.

Sample Containers and Handling

Field samples should be packaged and shipped to an USAF-approved analytical laboratory and analyzed for selected constituents. A chain-of-custody form must accompany the sample to ensure that samples are accounted from sample location to laboratory analysis. Sample containers should be affixed with a sample label which should be filled out at the time of collection. Information on the sample label should include: (1) Site location, (2) Sample designation, (3) Date and time of sample, (4) Initials of sampler, and (5) Parameters to be analyzed. Chain-of-custody forms should be initialed at the time of collection by the sampler. QA samples should be packaged and shipped to the Laboratory.

Samples should be placed inside the appropriate containers (e.g., plastic, glass) depending on the constituents of interest. Each sample should then be placed independently inside plastic bags (e.g., ziplock®). Samples contained in glass bottles should be wrapped in bubble pack to protect them during shipment. All samples should then be placed in a cooler containing bagged ice and the samples cooled to 4°C. The completed chain-of-custody form should be placed in a ziplock® bag and taped to the inside lid of the cooler. The cooler should then be sealed with adhesive tape and labeled for shipping. A custody seal should be placed across the lid and body of the cooler. The samples should be shipped via overnight express to the contracted

laboratory. Samples should be shipped within 2 days from the date of collection so that holding times may be met.

DATA QUALITY ASSURANCE OBJECTIVES

Data Quality Assurance Objectives (DQOs) are qualitative and quantitative statements that guide data collection and analysis to ensure that data collected are of adequate and sufficient quantity to support RI/FS and ATSDR decision making needs. DQOs are determined by the anticipated end uses of the data to be collected and should be developed for each data collection activity.

Data Uses

The DQOs for domestic well and ground water sampling are as follows:

- Assess the concentration of organic compounds possibly present in the ground water and compare these levels to applicable or relevant and appropriate requirements (ARARs), public health benchmark concentrations as specified by ATSDR, risk-based levels, or background levels as appropriate, based on project objectives.
- Characterize potential downgradient migration and contaminant transport from source areas.
- Perform a public health assessment of potential risk to human health from exposure to ground water at the sites.

The DQOs for the Biota sampling are as follows:

- Obtain necessary data to evaluate if a completed exposure pathway exists via the food chain.
- Analyze the edible portions of the flesh in order to evaluate the risk to human receptors.

The DQOs for the Air sampling are as follows:

- Obtain necessary air data to evaluate whether VOC emissions are a health concern for nearby receptors via the air pathway

The DQOs for the Swipe samples are as follows:

- Evaluate if PCB-containing transformer oil is present in the remaining concrete structures.

The DQOs for Soil Vapor monitoring are as follows:

- Obtain data to evaluate if there is a contaminant source or potential leak of petroleum hydrocarbons under the pipeline.
- Analyze the soil vapor in order to evaluate locations of future soil borings and surficial samples.

The DQOs for the ACM survey are as follows:

- Obtain necessary data to determine if friable ACM is present and to perform an asbestos removal, if necessary.

The DQOs for the surface water samples are as follows:

- Obtain data on the presence of glycol in the spring runoff to assess past and current exposures to these compounds.

All samples that are collected may also be used to provide data on site characterization, worker health and safety, risk assessment, evaluation of remedial alternatives, engineering design of remedial alternatives, and baseline data for continued monitoring.

Characteristics

Precision, accuracy, representativeness, completeness, and comparability (PARCC) parameters are measures of data quality that are standard QA objectives that must be met to ensure defensible data will be obtained. However, the following discussion of each individual PARCC has been abridged to reflect the limited amount of sampling to be performed at this site.

Precision

Duplicate samples should be analyzed at a frequency of 10 % of the total sample number to assess the reproducibility of measurements under the given conditions. Analytical results from field duplicate samples provide data on overall measurement precision. If sampling precision (which is more difficult to control and quantify than

analytical precision) is suspected to be a significant source of deviations, analytical precision should be assessed from one or more of the field samples. Biotic (fish) samples will be collected in triplicate to address this need.

For the analysis of fish tissue, the analyst's calibration checks, replicates, and spikes will be performed at a frequency of 10% and will be within specified control limits. Blind (sample bank) digestion standards, digestion spikes, digestion splits, digestion blanks and tissue splits will be analyzed at a frequency of 1 in 10.

Duplicate samples should be analyzed at a frequency of 10 % of the total sample number to assess the reproducibility of measurements under the given conditions. Analytical results from field duplicate samples provide data on overall measurement precision.

Accuracy

Accuracy of water samples should be characterized through analyses of trip blanks and QC samples. Trip blanks should be shipped with every cooler that contains volatile samples, and should be analyzed for volatile compounds only.

Biotic (fish) samples will be shipped to the receiving laboratory in nonmetallic containers (plastic, glass [with Teflon lids] that have been appropriately cleaned and rinsed) to diminish the possibility of extraneous metals contamination. Similarly in the laboratory, or in the field, Teflon coated or glass instruments should be used in the dissection of subsamples of fish for metals analysis. Glassware used in the analysis train also should be appropriately washed and rinsed to diminish extraneous metals contamination.

A trip blank also will be utilized during biotic sampling to attest to the cleanliness of transport containers. A dry ice and blender blank will be used to monitor the cleanliness of the tissue homogenization process.

Completeness

Completeness for water sampling should be achieved through the use of EPA Level III through Level IV analytical data quality.

Reporting Limits

Ground water sampling and analytical results will provide assessment of approximate concentrations of dissolved phase VOCs and fuel hydrocarbons in the potentially-affected aquifer(s). Since health effects associated with ingestion of contaminated

ground water can occur when organics are in the low $\mu\text{g/L}$ range, analysis of ground water samples requires detection limits within a similar range.

Biotic (fish) sampling and analysis results will provide assessment of approximate concentrations of metals in edible tissue. Since the suspected concentrations of metals in fish will likely be low ($< 10 \text{ mg/kg}$ wet weight), atomic absorption spectrophotometry should be the analytic method of choice whenever possible.

Data quality needs are met by the specified compound detection limits and the QA/QC protocols required by the analytical methods used. At a minimum, detection limits must be below potential ARARS applied to the data. For example, detection limits for ground water samples should be below National Primary Drinking Water Standards or other applicable standards. For this study, detection limits should be as specified by the analytical method chosen to analyze the samples. These methods should all be EPA analytical methods as listed in SW-846. The detection limits specified in the SW-846 methods are generally quite low and satisfy the DQO for this study. The use of standard sampling methods and validated EPA analytical methods ensures that detection limits will be comparable to previous studies.

QA Objectives

The quality of data obtained in the field for chemical analysis is evaluated using QA/QC samples. Quality assurance and quality control in accordance with methods outlined in the EPA document SW-846 or approved equal protocols is necessary to provide data of sufficient quality for public health assessment, risk assessment, and project purposes at the site.

Sample Designation

Samples should be designated with a two-letter sample type code followed by a two-digit designation of the year the sample was collected. This should be followed by the site-specific sample designation, sample location number, and sample depth, number of sample or well number. Sample types should be identified as follows:

- SB--Soil Boring (Subsurface Soil)
- SS--Surface Soil
- BT--Biota
- AS--Air Sampling
- MW--Ground water
- SW--Surface Water
- AB--Asbestos Bulk Sample

For example: SB93FT04-04-05 is a subsurface sample collected in 1993 at location FT-04 from soil boring No. 4 at 5 ft below grade. MW93FT04-03 is a ground water sample collected in 1993 at FT-04 at monitoring well No. 3.

QA/QC samples should be designated in the same manner as above with the following modifiers: "TB" for trip blank, "MS/MSD" for matrix spike and matrix spike duplicate, and "MS" for matrix spike. Duplicate QC samples should be identified as specified above, except that the sample location designation should be replaced by "D1," "D2," "D3," etc. Therefore, a duplicate sample would be MW93FT04-D1. Specific designation of the sample location where the duplicate was taken should be recorded in the bound field notebook. Although the laboratory will know that the sample is a duplicate, it will not know what sample has been duplicated and will have no basis upon which to modify results. The element of "routine" analysis should be preserved.

QA/QC Samples

QC samples are also known as duplicate, replicate, or split samples. The purpose of QA/QC samples is to test the precision of the laboratory analyses and determine if contamination was introduced into the sample. QA/QC samples should be preserved, handled, transported, and analyzed in a manner identical to the actual samples. QC samples are collected at a frequency of 10 % of the total number of field samples.

Equipment (Rinsate) Blanks

Equipment Blanks (Rinsate Blanks) are samples consisting of reagent-grade deionized water collected from a final rinse of sampling equipment after the decontamination procedure has been performed. The purpose of rinsate blanks is to assess whether sampling equipment may be contributing to cross-contamination of samples. Rinsate blanks should not be required when dedicated bailers are used.

Trip Blanks

Trip blanks are containers of reagent-grade deionized (DI) water that are kept with the field sample containers from the time they leave the laboratory until the time they are returned to the laboratory. The purpose of trip blanks is to assess whether samples have become contaminated during transit or sample collection. Trip blanks apply only to VOC analyses; therefore, the containers must contain no headspace. One trip blank is needed for each sampling event and will satisfy trip blank requirements for all VOC samples collected that day. All VOC samples, including the trip blank, collected each day should be appropriately packed and shipped in a single cooler. If more than one cooler is required for VOC samples, an additional trip blank should be included in each additional cooler containing VOC samples.

Trip blanks also will be employed when fish samples are collected. One trip blank is needed for each sampling event and will satisfy trip blank requirements for all fish samples collected that day. All fish samples, including the trip blank, collected each day should be appropriately packed and shipped in a single cooler.

Matrix Spike/Matrix Spike Duplicates

Matrix spike samples are samples which the laboratory "spikes" with known concentrations of designated compounds and then analyzes to assess percentage recoveries. These results test the accuracy attained by the laboratory instruments. Actual field samples are used for the spiking to detect matrix effects not related to compound levels which may interfere with the ability of laboratory instruments to make an accurate determination of compound concentrations. The matrix spikes should be prepared in the laboratory using 5 % of the samples received. The concentrations and compounds that should be used are in accordance with SW-846 QC protocols.

DATA MANAGEMENT

IRPIMS Data Requirements and Files

Data gathered in support of the Air Force IRP projects must be loaded into the Installation Restoration Program Information Management System (IRPIMS), a computerized database maintained by the USAF Armstrong Laboratories, located in San Antonio, Texas. Detailed requirements for content, format, and submission are included in the IRPIMS Data Loading Handbook (January 1991). Data collected in this activity, although not for IRP, should be entered into IRPIMS.

The data requirements for IRPIMS are rigorous. The eight file types and the respective components that contain data relevant to field operations are briefly described in this section. The IRPIMS Data Loading Handbook should be utilized as a reference document throughout this project.

Contract Information File

This file contains pertinent administrative data associated with a single contract. The components are: (1) Air Force Installation Identification, (2) Contract Number, (3) Delivery Order Number, (4) Submission Date, and (5) Data Loading Handbook Version.

Location Definition Information File

This file includes a unique identifying name and quantitative location information such as ground elevation, and northing and easting coordinates for discrete sampling locations. The horizontal coordinates should be referenced to the state planar system,

and the ground elevation should be referenced to the 1983 National Geodetic Vertical Datum if available. The components are: (1) Air Force Installation Identification, (2) Site Identification, (3) Location Identification, (4) Location Classification Code, (5) Location Proximity Code, (6) North State Plane Coordinate, (7) East State Plane Coordinate, (8) Surface Elevation, (9) Establishing Company Code, (10) Drilling Company Code, (11) Excavating Company Code, (12) Construction Method Code, (13) Date Established, (14) Borehole Depth, (15) Borehole Diameter, and (16) Location Description.

It is imperative that each Location Identification designation uniquely identify a sampling location and be consistently used each time the location is sampled since this column associates the sample data to a geographic location and relates the information in all IRPIMS data files to one another.

Site and Location Information File

This file lists the sampling or monitoring locations in the proximity of each site. This file includes a code that describes the hydraulic relationship, such as downgradient, upgradient, or cross-gradient, between a sampling or monitoring location and a site. The components are: (1) Air Force Installation Identification, (2) Site Identification, (3) Site Name, (4) Site Cross Reference, (5) Location Identification, and (6) Geohydrologic Flow Classification.

Environmental Sampling Information File

This file contains information particular to sampling (*i.e.*, date, method, type) and includes a field lot control number which is used to relate the sample to its corresponding field QC samples. One record is generated per sample. The components are: (1) Air Force Installation Identification, (2) Location Identification, (3) Log Date, (4) Log Time, (5) Lot Control Number, (6) Logging Company Code, (7) Sample Beginning Depth, (8) Sample Ending Depth, (9) Sampling Method Code, (10) Sampling Matrix, and (11) Sample Type Code.

The Lot Control Number is the value used to tie the analytical results of a sample with the analytical results of its associated field QC samples. The first character in this column identifies the sample's associated ambient conditions blank, the second character identifies the associated equipment blank, the third character identifies the associated trip blank, and the fourth and final character identifies the cooler in which the sample was shipped.

Data Management Techniques

Logging and tracking of samples collected for analysis should be facilitated by a sample custody data entry application. The individual collecting samples in the field should fill out chain-of-custody forms and field data sheets. The field data sheets should include the information needed to fulfill all requirements of IRPIMS. The information from

the field data sheets should be entered into a computer database by field sampling personnel via data entry software. This database should be used to generate sample custody documentation and an input file to be given to the laboratory for assimilation into its internal sample tracking and data management system. The use of the sample custody database application accomplishes the following objectives: (1) Ensures that sampling information collected meets the requirements of the data base IRPIMS, (2) Checks the integrity and completeness of the sampling data, and (3) Provides an input for laboratory data management that is consistent with the data files used for geotechnical data management.

The location and geotechnical data should be entered by field sampling personnel using a computer data entry application. This application should ensure adherence to IRPIMS requirements. As output, it should produce boring logs and well completion diagrams for technical analysis and report writing, IRPIMS-compatible input files for delivery to USAF Armstrong Laboratories, and a working database for further analysis of the data.

COST ESTIMATE

The following cost analysis is based on contracting the proposed data gap sampling to a new contractor. Incorporating recommended sampling efforts into current investigations should result in decreased costs. Previous contractor-generated cost estimates were used to project the costs associated with performing DGSAP recommended sampling. The cost estimate appears in Table 5.

Table 5. Cost Estimate

Site Description	CY94\$
LF-1/Green Pond	12,000
SS-04/Receptor Site (Jackson Well)	2,500
SS-17/Underground Transformer Vaults	6,000
ST-10/Flight Line Drainage Ditch	3,500
OU-12/Flight Line	8,000
On-base segment of Searsport Pipeline	10,000
Former Army Barracks foundation and Bldgs Near Weapons Storage Area	7,000
Total	49,000

APPENDIX A. ATSDR SCOPING VISIT
(19 November 1991)



DEPARTMENT OF HEALTH & HUMAN SERVICES

Public Health Service
Agency for Toxic Substances
and Disease Registry

Memorandum

Date November 19, 1991

From Environmental Health Scientist, FPB, DHAC
Environmental Health Scientist, FPB, DHAC
Environmental Engineer, FPB, DHAC

Subject Health Consultation: Loring Air Force Base, Limestone, ME
Public Health Issues Discovered During the Scoping Visit

To Louise A. House
ATSDR Regional Representative, U.S. EPA, Region I
Through: Director, DHAC [Signature]
Acting Chief, FPB [Signature]

BACKGROUND AND STATEMENT OF ISSUES

Loring Air Force Base (LAFB), in Aroostook County at the northeastern tip of Maine, occupies approximately 9,000 acres in the lower Aroostook River Basin. The base is approximately two miles northwest of the town of Limestone, eight miles northeast of Caribou, and three miles west of the Canadian border. The townships of Caswell and Conner border the base on the north and northwest, respectively.

LAFB's water system draws from the Little Madawaska River, northwest of the base, but several buildings on base draw water from groundwater wells. Limestone and Caribou are partially served by public water supplies drawn from surface waters that are not expected to be influenced by contamination from LAFB. All residences and farms near the base have private groundwater wells.

The base, which is scheduled to be closed in September 1994, is on the National Priorities List (NPL) because of groundwater contamination in proximity to private drinking water wells. Through the Department of Defense Installation Restoration Program, 21 potential sources are being investigated. Free diesel product is in the groundwater near the base Receiver Site. A layer of JP4 fuel is also in the groundwater at the Fuels Tank Farm.

Seeps from Landfill #1, containing volatile organic compounds (VOCs) and zinc drain into Green Lake, which is stocked with trout each year for consumption by base personnel. Some wells and surface waters near Landfill #3 have elevated concentrations of metals and organics. Sampling of well JMW 907 showed lead at 25 µg/L. Surface water samples contained 80 µg/L of lead, 11 µg/L arsenic, 29 µg/L chromium, 609 µg/L zinc, 17 µg/L 1,2-dichloroethane, and 42 µg/L toluene.

The monitoring data indicate that both surface water and groundwaters contain potentially hazardous concentrations of contaminants. The available documents do not include information on regional or local groundwater flow paths, or hydraulic continuity between surface waters and the surficial and limestone aquifers. Although LAFB has known of the contamination for several years, only one of the residential drinking water wells near the known areas of contamination has been analyzed. That well which was sampled twice in 1988, showed "oil and grease" contamination the first time and no contamination the second time. It has not been resampled. Consequently, it is not possible to predict the distribution of, or potential human exposures to, these contaminants.

ATSDR personnel visited LAFB September 17-20, 1991, to conduct a scoping visit and site evaluation. The health assessment for LAFB is scheduled to be initiated in FY92.

DOCUMENTS REVIEWED

Remedial Investigation/Feasibility Study, Installation Restoration Program, Loring Air Force Base, Limestone, Maine, RI Status Report, Volumes I-III, August 1990

Community Relations Plan, August 1991

1986 Aroostook River Atlantic Salmon Management Report

U.S. Geological Survey Maps

DISCUSSION

During the outbriefing with LAFB officials, ATSDR representatives stated that the following studies/actions are needed to evaluate, mitigate, or prevent adverse human health effects.

1. Define groundwater direction and extent of contamination plumes to determine potential receptor populations.
2. Sample wells at the East Gate Estates and West Gate Villa trailer parks to determine if they are contaminated.
3. Add VOCs, propylene glycol, and ethylene glycol as parameters for all samples.
4. Initiate VOC sampling of on-base water systems that draw from groundwater as soon as possible, and increase sampling frequency. Current sampling frequency is once

5. Conduct a well inventory in the vicinity of the Receiver Station to determine well depths. Expand monitoring as appropriate, based on inventory results.
6. Characterize surface-water and sediment contamination from the flight line. If contamination is found at the base property boundary, continue characterization off base.

CONCLUSIONS AND RECOMMENDATIONS

After reviewing information received during the site visit and from other sources following the site visit, ATSDR is expanding its comments and recommendations regarding the six areas of concern discussed during the outbriefing. Additional data could alter the following recommendations.

1. Define groundwater direction and extent of contamination plumes to determine potential receptor populations.

Additional sampling is needed to determine the areal extent of contamination plumes at LAFB, particularly at Landfill #1 (Site 1), Landfill #2 (Site 8), Landfill #3 (Site 9), the Fuels Tank Farm (Site 6), the Receiver Site (Site 12), and the East Gate Waste Storage Tanks (Site 14). These sites are closest to LAFB boundaries and therefore have the greatest potential effect on private drinking water wells at residences near the base and the Ski Chalet on base.

2. Sample the wells at the East Gate Estates and West Gate Villa trailer parks to determine if they are contaminated.

In addition to the two trailer parks' wells, LAFB should also begin monitoring the drinking-water wells at other private residences within a 0.5 mile radius of the Receiver Site, Landfills #1 and #3, and the Fuels Tank Farm/East Gate Waste Storage Tanks area to determine whether they are contaminated with the organics and/or metals known or suspected to be at those sites. ATSDR recommends that this monitoring be initiated as soon as possible and be conducted on a regular basis, such as annually, if contamination is not found initially.

Monitoring should continue until contamination plumes have been delineated and the area hydrogeology is sufficiently understood to preclude that the private wells will be affected. ATSDR requests that the sampling and analytical results be provided to the Agency when they are available. If EPA and/or Maine Department of Environmental Protection must approve the LAFB sampling and analytical protocol, we

request that the Agencies expedite the approval process.

3. Add VOCs, propylene glycol, and ethylene glycol as parameters for all samples.

Because of the known organic contamination in several areas of LAFB and the extensive use of deicers in the winter, ATSDR recommends that all samples be analyzed for VOCs, propylene glycol, and ethylene glycol.

4. Initiate VOC sampling of on-base water systems that draw from the groundwater as soon as possible, and increase sampling frequency. Current frequency is once every three to five years.

Because LAFB has documented organic contamination in groundwater at several locations, ATSDR recommends that all base water systems that draw from groundwater be analyzed at least annually for VOCs. Monitoring for VOCs should be initiated as soon as possible to determine if the wells are already contaminated and need to be replaced, or if treatment is needed before the water is used. ATSDR recognizes that LAFB is currently analyzing these systems for VOCs on a schedule specified by the state of Maine.

5. Conduct a well inventory in the vicinity of the Receiver Station to determine well depths. Expand monitoring as appropriate based on inventory results.

This suggestion is now superseded by the discussion under recommendation number 2. Because of the fractured geology and lack of information on the regional or local groundwater flow paths in this part of Maine, the decision about which wells to sample should not be based solely on well depths.

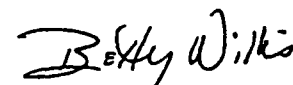
6. Characterize surface water and sediment contamination from the flight line. If contamination is found at the base property boundary, continue characterization off base.

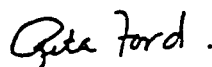
In 1986, the Maine Department of Inland Fisheries and Wildlife stocked Greenlaw Brook with 3,000 salmon fry to determine the feasibility of restoring the salmon population in this and other tributaries of the Aroostook River. Electrofishing results revealed that all fry in

this stream had eroded caudal fins. Some fish also had erosion of pectoral fins (see "1986 Aroostook River Atlantic Salmon Management Report").

In 1988, a basewide surface water and sediment study was conducted at 20 locations. Fuel-related VOCs, semivolatile organic compounds, and petroleum hydrocarbons (PHCs) were detected in surface water and sediments at several locations of the east branch of Greenlaw Brook. Two sediment samples upstream from the Ski Chalet had 1.5% and 1.6% PHC. Sediments in the branch near the Ski Chalet contained 1,311 mg/kg PHC. ATSDR recommends that LAFB sample the sediments and surface waters to determine what specific chemicals are present in areas accessible to children on base. More extensive sediment sampling is also needed at the base boundaries to determine if contaminants are migrating off base. If contamination is found at the base boundary, LAFB should continue its study off base.


Lorna Bozeman


Betty Willis


Rita Ford

cc:
Captain Cunningham
Colonel Brown
HQ USAF/CEV
USAF Armstrong Laboratory/OE
Loring Air Force Base, ME
Lt. Kenneth Finger
Mark Bashor
RIMB

ATSDR/DHAC/FPB/BWILLIS/bj
DOC. LORING\LORING.HC,111991

**APPENDIX B. ATSDR CORRESPONDENCE TO
LORING AFB
(25 November 1991)**



DEPARTMENT OF HEALTH & HUMAN SERVICES

Public Health Service

Agency for Toxic Substances
and Disease Registry
Atlanta GA 30333

November 25, 1991

Colonel Gary Schneider
Wing Commander
Loring AFB, Maine 04751-5300

Dear Colonel Schneider:

Handwritten: *4 Dec 91*

	Act	Info
OEP		
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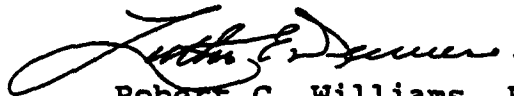
ATSDR personnel visited Loring Air Force Base on September 17-19, 1991, to conduct a scoping visit. During the outbriefing with you, the health assessment team identified studies and actions that are needed to evaluate, mitigate, or prevent adverse human health effects. After reviewing the information received during the site visit, ATSDR is expanding its comments and recommendations regarding the six areas of concern discussed during the outbriefing:

1. Define groundwater direction and extent of contamination plumes to determine potential receptor populations;
2. Sample the wells at the East Gate Estates and West Gate Villa trailer parks to determine if the wells are contaminated;
3. Add volatile organic compounds (VOC), propylene glycol, and ethylene glycol as parameters for all sampling;
4. Initiate VOC sampling of on-base water systems that draw from the groundwater as soon as possible, and increase sampling frequency. Current frequency is once every three to five years;
5. Conduct a well inventory in the vicinity of the Receiver Station to determine well depths. Expand monitoring of private wells as appropriate; and
6. Characterize surface water and sediment contamination from the flight line. If contamination is found at the base property boundary, continue characterization off base.

Page 2 - Colonel Schneider

The enclosed health consultation provides a detailed discussion of the background, issues, conclusions, and recommendations. A list of documents that were reviewed is also provided. If you or your staff have any questions concerning the health consultation, please contact Ms. Betty Willis at 404/639-0600.

Sincerely yours,

A handwritten signature in dark ink, appearing to read "Robert C. Williams", with a stylized flourish at the end.

Robert C. Williams, P.E.
Director
Division of Health Assessment
and Consultation

Enclosure

**APPENDIX C. ATSDR SITE SUMMARY REPORTS -
LORING AFB**

DRAFT

**Loring Air Force Base (LAFB)
Limestone, Maine**

Service: USAF

Size: 9,000 acres

Installation Status: Active but scheduled for closure in
September 1994

Installation Mission: Headquarters to Strategic Air Command's
42nd Bombardment Wing

ATSDR Action Dates:

Initial Site Scoping Visit: 09/16-20/91

TRC/Other Meetings: Not attended

Projected Initiation of Action: FY93*

* Projection based on anticipated full funding and personnel status.

Site Scoping Visit:

Met with:

Col Gary Schneider, LAFB

Capt Thomas Luna, LAFB

Lt Kenneth Finger, LAFB

TSgt Willie Smith, LAFB

Sgt Joann Scibetta, LAFB

Dave Hopkins, LAFB

Dennis St. Peter, LAFB

Norman McPherson, LAFB

Desa Holmes, LAFB

Thomas Stevens, Limestone Town Manager

Mary Hunter, Limestone Town Planner

Nolan Hafford, Caribou Water Department

Save Loring Committee Spokesperson

Accomplishments:

- contacted Maine Agricultural Experiment Station and Extension Service staff to obtain information regarding area agricultural practices
- contacted Maine Inland Fisheries and Wildlife Department regarding freshwater fishing in the vicinity of LAFB
- contacted Carey Medical Center Laboratory Director to determine sources of health outcome data
- toured sites on LAFB and received briefing on site-related activities

Ranking Category: C

No completed pathways of human exposure were identified. No specific community health concerns were reported.

DRAFT

Loring Air Force Base - Page 2

Preliminary Findings:

The groundwater is contaminated with fuels in several areas, but plume characterization is incomplete. Groundwater is used as a drinking water source in some of those areas. In the past, open burning was done at LAFB landfills. The public health implications of future land use need to be considered prior to base closure.

The primary environmental contaminants at LAFB are VOCs, fuels, metals, PCBs, and explosives. Reportedly, radioactive wastes were disposed of in a high security area within the installation.

Potential exposure pathways identified at LAFB are groundwater, surface water, sediments, air, and the food chain.

Possible receptor populations include on- and off-site residents using contaminated potable water (wells or surface water), persons who eat fish from surface water potentially contaminated by source areas on LAFB, residents down wind of installation landfills where open burning was done in the past, and on-site workers and others who contact contaminated environmental media.

Comments:

ATSDR addressed the public health concerns identified during the September site visit in a November 25, 1991 health consultation. Recommendations include defining groundwater direction and extent of contamination plumes; sampling wells at the East Gate Estates and West Gate Villa trailer parks; adding VOCs, propylene glycol, and ethylene glycol as parameters for all sampling; initiating VOC sampling of on-base water systems that draw from groundwater and increase sampling frequency; conducting a well survey in the vicinity of the Receiver Station and expanding monitoring of private wells as appropriate; and characterizing surface-water and sediment contamination emanating from the flight line.

In July 1991 the Final Project Workplan was made available as part of the IRP at LAFB.

**APPENDIX D. ADDENDUM TO THE HEALTH
CONSULTATION FOR THE LORING AIR FORCE BASE
(17 February 1993)**

Addendum to the Health Consultation

for the

**Loring Air Force Base
Limestone, Maine**

**Prepared by
Federal Programs Branch
Division of Health Assessment and Consultation**

February 17, 1993

Background and Statement of Issues

Loring Air Force Base (LAFB), in Aroostook County at the northeastern tip of Maine, occupies approximately 9,000 acres in the lower Aroostook River Basin. The base is approximately 2 miles northwest of the town of Limestone, 8 miles northeast of Caribou, and 3 miles west of the Canadian border. The townships of Caswell and Conner border the base on the north and northwest, respectively.

ATSDR personnel visited LAFB September 17-20, 1991, to conduct a scoping visit and site evaluation. Following the site visit, a health consultation was issued on November 19, 1991. In the consultation, ATSDR requested private well sampling at the East Gate Estates and West Gate Villa trailer parks and private residences within a 0.5 mile radius of the Receiver Site, Landfills #1 and #3, and the Fuels Tank Farm/East Gate Waste Storage Tanks were included in the consultation.

The sampling data has been provided to ATSDR for evaluation. This addendum to the health consultation is ATSDR's evaluation of the off-base residential well sampling data.

Discussion

Samples were analyzed for volatile organic compounds, semivolatile organic compounds, and inorganics. Eleven of 13 wells in the area were sampled. Split samples were collected by Maine Department of Environmental Protection and ABB Environmental Services (contractors to LAFB). The owner of one well did not allow a sample to be taken; the owner of the second well was out of town during the sampling period. Sampling was conducted as specified in the Residential Well Sampling and Analysis Plan (April 1992).

ATSDR has reviewed the off-base residential well sampling data (LAFB 1992) and determined manganese to be the only contaminant of public health concern. Although this contaminant is

potentially not related to contamination at LAFB, this addendum to the consultation will evaluate possible adverse health effects that may occur as a result of exposure to this contaminant. For chemical specific information see Attachment 1.

Manganese was detected in one of the 11 wells sampled at a concentration above the Environmental Protection Agency's Reference Dose (RfD) and the state of Maine's Maximum Exposure Guideline (MEG). RfDs and MEGs are health-based guidelines. The RfD is an estimate of the daily exposure for the human population, including sensitive subpopulations, that is likely to be without a detectable risk of adverse health effects during a lifetime. The MEG is the concentration of that compound in drinking water below which no adverse health effects are expected to occur over a lifetime of exposure.

The RfD for manganese in water is 0.005 mg/kg/day (IRIS2, 1993). The MEG is 50 ppb (state of Maine, 1992). The Food and Nutrition Board of the National Research Council estimated the safe and adequate intake of manganese to be 2.5-5 mg/day for adults and 0.7-1.0 mg/day for infants (ATSDR, 1992).

Animal studies have indicated that oral exposure to manganese may lead to neurologic effects. In those studies, doses of about 980 mg/day for adults and 5-10 mg/day for infants were calculated as the neurologic effect level (ATSDR, 1992). While data from animal studies suggest that typical human exposure levels are not of concern to either adults or infants, it must be remembered that animals do not appear to be as sensitive to manganese as humans. Thus, there is considerable uncertainty in using animal data to estimate a no-effect oral exposure level in humans.

Manganese was detected off-base at a concentration of 1840 ppb in the well at Carpenter's Service Station (Loring AFB, 1992). The well is used by the service station and a private residence as a drinking water source. In addition, the service station uses the water to make coffee that is sold to customers (Loring AFB, 1993). Therefore, the health consultation will evaluate exposure in both residential, customer, and worker scenarios.

Daily estimated exposure doses (see below for exposure assumptions) from drinking water at Carpenter's Service Station (residential scenario) are 0.052 mg/kg/day (3.6 mg/day) for adults, 0.11 mg/kg/day (1.76 mg/day) for children, and 0.184 mg/kg/day (1.84 mg/day) for infants. The daily estimated exposure dose is 0.019 mg/kg/day (1.82 mg/day) for workers and 0.005 mg/kg/day for customers. The estimated exposure doses for all groups is equal to or greater than the RfD (0.005 mg/kg/day). In addition, the estimated exposure dose for infants is greater

than the safe and adequate intake for infants. Therefore, daily consumption of water from the well at Carpenter's Service Station is of public health concern for all groups. However, adverse health effects for adults, workers, and customers are unlikely.

Exposure Assumptions for Estimating Exposure Dose

Group	Water Intake Rate liters/day	Body Weight (kg)	Exposure Factor
Adult	2	70	7 days/week
Children	1	16	7 days/week
Infant	1	10	7 days/week
Workers	1	70	5 days/week
Customer	0.25	70	5 days/week

Daily manganese intake among individuals varies greatly, depending upon dietary habits. For example, an average cup of tea may contain 0.4-1.3 mg of manganese; nuts, 18.21-46.83 mg/kg; and fruits, 0.20-10.38 mg/kg (ATSDR, 1992). People ingesting large amounts of foods high in manganese have the potential for above-average exposure. Included in this group are vegetarians and those who drink large amounts of tea. Infants may also be ingesting amounts greater than the estimated safe and adequate dose for their age group (ATSDR, 1992) due to high manganese levels in prepared infant foods and formulas (ATSDR, 1992). Infant foods have been reported to contain 0.17-4.83 mg/kg of manganese (ATSDR, 1992).

With the additional intake from foods, infants may approach the neurological effect level calculated from animal studies (5-10 mg/day). Therefore, drinking water from Carpenter's Service Station well on a daily basis (residential scenario) is of particular concern for infants. It is unlikely that total exposure (food and water) for adults would approach the neurological effect level of 980 mg/day for any of the exposure groups (residence adults, workers, or customers). Therefore, adverse neurological effects are unlikely for adults exposed to manganese via drinking water from the service station well.

It is generally considered that uptake across skin is very limited for most inorganic metal ions. Therefore, dermal exposure to water from this well is not considered to be a health

concern.

Conclusions

- The well should not be used as a residential or business drinking water source.
- Commercial uses of the water, such as washing cars, is not of public health concern.
- Dermal exposure is not of public health concern. Therefore, sanitary uses are not of public health concern.

Recommendations

- Sample the well at Carpenter's Service Station for confirmation of manganese contamination. If contamination is confirmed, provide an alternate drinking water source.
- Sample the well owned by the person who was "out of town" during the sampling period.

Susan McAfee Moore
Environmental Health Scientist

References cited

Agency for Toxic Substances and Disease Registry. Toxicological Profile for Manganese. Atlanta: ATSDR, July 1992.

Loring Air Force Base. Letter to Rita Ford: Off Base Residential Well Sampling Results. August 17, 1992.

Loring Air Force Base. FAX from Peter G. Breed. Well usage at Carpenter's service station. January 26, 1993.

IRIS2. 1993. Integrated Risk Information System. U.S. Environmental Protection Agency, Washington, DC. January 1993.

State of Maine. Department of Human Services. Memo: Revised Maximum Exposure Guidelines. Robert A. Frakes. October 23, 1992.

References reviewed

Collipp PJ, Chen SY, Maitinsky S. 1983. Manganese in infant formulas and learning disability. *Ann Nutr Metab* 27:488-494.

Kondakis XG, Makris N, Leotsinidis M, et al. 1989. Possible health effects of high manganese concentration in drinking water. *Arch Environ Health* 44:175-178.

Pennington JAT, Young BE, Wilson DB, et al. 1986. Mineral content of foods and total diets: The selected minerals in foods survey, 1982 to 1984. *J Am Diet Assoc* 86:876-891.

Fact Sheet - Manganese

Manganese is a naturally occurring element that exists in the environment primarily as salts or oxide of Mn(+2) or Mn(+4). Results of animal studies suggest that people have a nutritional requirement for manganese. The Food and Nutrition Board of the National Research Council has estimated the adequate and safe intake of manganese to be 2.5-5 mg/day for adults and 0.7-1.0 mg/day for infants (1).

The amount of manganese absorbed across the gastrointestinal tract in humans is rather variable, but usually averages about 3-5% (1). One of the key determinants of absorption is dietary iron intake. Low iron levels lead to increased manganese absorption.

Although manganese is beneficial at low intake levels, intake of higher levels can cause adverse effects. There is clear evidence that inhalation exposure to manganese dusts in mines and factories can lead to manganism, a neurologic disorder that typically begins with feelings of weakness and lethargy and progresses to a slow and clumsy gait, speech disturbances, a mask-like face, and tremors. The affected person may develop severe hypertonia and muscle rigidity and become permanently disabled. There is only limited evidence that oral exposure to manganese is of concern; however, several individuals have reported similar symptoms after ingesting high levels of manganese (14 mg/L in drinking water). The similarity of the effects seen in persons who drank manganese-contaminated water and persons who experienced inhalation exposure suggests that excess manganese intake might lead to neurologic injury.

Animal studies have also indicated that oral exposure may lead to neurologic effects. In those studies, intakes of about 980 mg/day for adults and 5-10 mg/day for infants were calculated as the neurologic effect level.

Sensitive populations include infants, elderly persons, and persons with impaired biliary secretion. Infants are potentially susceptible to the effects of manganese because they may retain a much higher percentage of ingested manganese than adults. Elderly people are potentially susceptible due to neuronal loss from aging. Manganese is primarily excreted via the liver. Therefore, persons with impaired secretion capacity would be expected to have diminished ability to handle manganese excesses.

Dermal exposure is not considered to be of health concern -- except to KMnO_4 , which is corrosive. Data are not adequate to reach a firm conclusion about the carcinogenicity of manganese, but suggest that the potential for carcinogenic effects in people

is small.

Reference

1. Agency for Toxic Substances and Disease Registry.
Toxicological Profile for Manganese. Atlanta: ATSDR, July
1992.

Contacts for Loring AFB Site Issues

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